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Authentic Learning for the 21st Century: An Overview

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Abstract

Learning-by-doing is generally considered the most effective way to learn. The Internet and a variety of emerging communication, visualization, and simulation technologies now make it possible to offer students authentic learning experiences ranging from experimentation to real-world problem solving. This white paper explores what constitutes authentic learning, how technology supports it, what makes it effective, and why it is important.

Students say they are motivated by solving real-world problems. They often express a preference for *doing* rather than *listening*. At the same time, most educators consider learning-by-doing the most effective way to learn. Yet for decades, authentic learning has been difficult to implement. Certain experiments are too dangerous, difficult, or expensive to conduct in the classroom; many are simply impossible to perform. After all, educators cannot expect their students to set the tectonic plates in motion, summoning up an earthquake at will, or to travel back in time and replay decisive moments in the American Civil War, can they? Well, perhaps they can.

Thanks to the emergence of a new set of technological tools, we can offer students a more authentic learning experience based on experimentation and action. With the help of the Internet and a variety of communication, visualization, and simulation technologies, large numbers of undergraduates can begin to reconstruct the past, observe phenomena using remote instruments, and make valuable connections with mentors around the world. With access to online research communities, learners are able to gain a deeper sense of a discipline as a special "culture" shaped by specific ways of seeing and interpreting the world. They begin to grasp the subtle, interpersonal, and unwritten knowledge that members in a community of practice use (often unconsciously) on a daily basis. "Learning becomes as much social as cognitive, as much concrete as abstract, and becomes intertwined with judgment and exploration,"[1] just as it is in an actual workplace.

Developmental psychologist Jerome Bruner reminds us that there is a tremendous difference between learning *about* physics and learning *to be* a physicist. Isolated facts and formulae do not take on meaning and relevance until learners discover what these tools can *do* for them.[2] As George Siemens suggests, learning to be a physicist, a chemist, or an historian is all about forging concrete connections—interpersonal connections between apprentices and mentors, intellectual connections between the familiar and the novel, personal connections between the learner's own goals and the broader concerns of the discipline.[3]

Connection-building will require new forms of authentic learning—forms that cut across disciplines and bring students into meaningful contact with the future employers, customers, clients, and colleagues who will have the greatest stake in their success. Without a doubt, technology will play an essential supporting role. This white paper presents an overview of authentic learning, beginning with a set of basic questions:

- What is authentic learning?
- How does IT support authentic learning?
- What makes authentic learning effective?
- Why is authentic learning important?

What Is Authentic Learning?

Authentic learning typically focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice. The learning environments are inherently multidisciplinary. They are "not constructed in order to teach geometry or to teach philosophy. A learning environment is similar to some 'real world' application or discipline: managing a city, building a house, flying an airplane, setting a budget, solving a crime, for example."[4] Going beyond

content, authentic learning intentionally brings into play multiple disciplines, multiple perspectives, ways of working, habits of mind, and community.

Students immersed in authentic learning activities cultivate the kinds of "portable skills" that newcomers to any discipline have the most difficulty acquiring on their own:

- The *judgment* to distinguish reliable from unreliable information
- The *patience* to follow longer arguments
- The *synthetic ability* to recognize relevant patterns in unfamiliar contexts
- The *flexibility* to work across disciplinary and cultural boundaries to generate innovative solutions[5]

Learning researchers have distilled the essence of the authentic learning experience down to 10 design elements, providing educators with a useful checklist that can be adapted to any subject matter domain.[6]

1. *Real-world relevance*: Authentic activities match the real-world tasks of professionals in practice as nearly as possible. Learning rises to the level of authenticity when it asks students to work actively with abstract concepts, facts, and formulae inside a realistic—and highly social—context mimicking "the ordinary practices of the [disciplinary] culture."[7]

2. *Ill-defined problem*: Challenges cannot be solved easily by the application of an existing algorithm; instead, authentic activities are relatively undefined and open to multiple interpretations, requiring students to identify for themselves the tasks and subtasks needed to complete the major task.

3. *Sustained investigation*: Problems cannot be solved in a matter of minutes or even hours. Instead, authentic activities comprise complex tasks to be investigated by students over a sustained period of time, requiring significant investment of time and intellectual resources.

4. *Multiple sources and perspectives*: Learners are not given a list of resources. Authentic activities provide the opportunity for students to examine the task from a variety of theoretical and practical perspectives, using a variety of resources, and requires students to distinguish relevant from irrelevant information in the process.

5. *Collaboration*: Success is not achievable by an individual learner working alone. Authentic activities make collaboration integral to the task, both within the course and in the real world.

6. *Reflection (metacognition)*: Authentic activities enable learners to make choices and reflect on their learning, both individually and as a team or community.

7. *Interdisciplinary perspective*: Relevance is not confined to a single domain or subject matter specialization. Instead, authentic activities have consequences that extend beyond a particular discipline, encouraging students to adopt diverse roles and think in interdisciplinary terms.

8. *Integrated assessment*: Assessment is not merely summative in authentic activities but is woven seamlessly into the major task in a manner that reflects real-world evaluation processes.

9. *Polished products*: Conclusions are not merely exercises or substeps in preparation for something else. Authentic activities culminate in the creation of a whole product, valuable in its own right.

10. *Multiple interpretations and outcomes*: Rather than yielding a single correct answer obtained by the application of rules and procedures, authentic activities allow for diverse interpretations and competing solutions.

Educational researchers have found that students involved in authentic learning are motivated to persevere despite initial disorientation or frustration, as long as the exercise simulates what really counts—the social structure and culture that gives the discipline its meaning and relevance.[8] The learning event essentially encourages students to compare their personal interests with those of a working disciplinary community: “Can I see myself becoming a member of this culture? What would motivate me? What would concern me? How would I work with the people around me? How would I make a difference?”

Colleges and universities across the country are turning to authentic learning practices and putting the focus back on the learner in an effort to improve the way students absorb, retain, and transfer knowledge. Following are examples of authentic learning practices and their benefits.

Simulation-Based Learning

The Mekong e-Sim is an online learning environment that uses simulation and role-playing to immerse students in the complexities of authentic decision making, helping them develop the communication, collaboration, and leadership skills they will need to be successful practitioners in their fields. By asking students to assume the identities of stakeholders in the Mekong River Basin of Southeast Asia and debate the merits of a proposed development project, the Mekong e-Sim offers a structured method of exposing students to the wide range of social, political, economic, and scientific conflicts that affect complex engineering projects, particularly those that may be multinational in scope. Students from different disciplinary backgrounds (including civil, environmental, telecommunications, software, and mechanical) have used this learning tool to collaborate with others on authentic problems of global importance. (See <http://www.educause.edu/ir/library/pdf/ELI5014.pdf>.)

Student-Created Media

Students in The University of British Columbia’s Department of Classical, Near Eastern, and Religious Studies have created 3D virtual reconstructions of the ancient Athenian marketplace known as the agora and were required to present a rationale for the design choices they made as they built their replicas of the agora’s theater, museum, and mint. Working from forensic evidence, including data from aerial photos, satellite images, surface surveys, topographic maps, structure measurements, and what is known as the “material culture assemblage”—or the accumulation of shards (pottery, stone tools, and so on) found on the occupation layers of the site—students employing the Ancient Spaces 3D model editor are able to learn by doing or, more precisely, learn by reconstructing key architectural and artistic environments of the ancient world. (See <http://www.educause.edu/ir/library/pdf/ELI5012.pdf>.)

Inquiry-Based Learning (Open Learning Initiative)

At Carnegie Mellon University, cognitive scientists are teamed with expert faculty in a variety of disciplines to reach an understanding of where novices commonly run into trouble when introduced to unfamiliar material in a particular field. With this information in hand, the teams design Web-based courses that are "cognitively guided," providing students with the scaffolding they need at every stage of their development as preprofessionals. For example, an instructor teaching a course on the mathematics that underlie chemistry asks students to investigate a real-world problem: arsenic contamination of the water supply in Bangladesh. Learners are introduced to key concepts and practice targeted skills while instructors, aware of common student misunderstandings, check for comprehension and provide feedback. Using additional "what if" questions, instructors help students continue to think flexibly about applying their newly acquired skills to other situations. (See <http://www.educause.edu/ir/library/pdf/ELI5013.pdf>.)

Peer-Based Evaluation

Calibrated Peer Review (CPR) is a free Web-based program that allows instructors to incorporate frequent writing assignments into their courses, regardless of class size, without increasing their grading workload. Students are trained to be competent reviewers and are then given the responsibility of providing their classmates with personalized feedback on expository writing assignments. Meanwhile, with access to all student work, instructors can monitor the class as a whole and assess the progress of each student. The CPR system manages the entire peer-review process, including assignment creation, electronic paper submission, student training in reviewing, student input analysis, and final performance report preparation. (See <http://www.educause.edu/ir/library/pdf/ELI5002.pdf>.)

Working with Remote Instruments

Through a browser interface, MIT makes it possible for students around the world to conduct experiments with specialized equipment located on the MIT campus, including a shake table that simulates earthquakes and a sensor-equipped flagpole that measures meteorological parameters. Software agents oversee instrument usage, assigning priorities to individual experiments. For students without immediate access to expensive specialized equipment or extremely rare scientific instruments, this approach can open the door to active learning experiences that would otherwise be beyond their reach. (See <http://www.educause.edu/ir/library/pdf/ELI7013.pdf>.)

Working with Research Data

In disciplines from ornithology to social history, students are becoming legitimate peripheral participants in virtual communities of practice, collecting data either first-hand or through remotely located smart sensors. In other cases, students use data collected by researchers (such as virtual sky data accessible through the National Science Digital Library Project) to conduct their own investigations. They are practicing higher-order analysis on real data sets while contributing to the common knowledge base.

Reflecting and Documenting Achievements

In 2001, the mechanical engineering faculty at UT Austin needed a way of documenting and sharing student projects, tracking the achievement of learning objectives, reinforcing the link between class work and real-world engineering concerns, and encouraging students to reflect on their own learning processes. Polaris, an in-house e-portfolio system, was created. UT engineering students not only use their e-portfolios to showcase their best work and evaluations for prospective employers; Polaris also supports the learning process. The system uses a "metacognitive" strategy that encourages students to study their own learning patterns in an effort to improve their performance over time. In addition, a feedback cycle allows students to post their individual work electronically, perform intra-group and extra-group reviews, question project assumptions, and learn to critique their peers constructively, as they must do throughout their engineering careers. See <http://www.educause.edu/ir/library/pdf/ELI5015.pdf>.)

How Does IT Support Authentic Learning?

Authentic learning is not new. It was the primary mode of instruction for apprentices who later took their places within established craft guilds. At one time apprenticeship was the most common form of learning. However, as the numbers of students grew in the 19th century, the logistics and economics of transporting large numbers of students to relevant work sites made large-scale apprenticeship programs impractical. Other risks emerge associated with managing the activities of novices in workplaces, opening institutions up to significant liability should student interns injure themselves or others.[9]

Significantly, educational researchers are coming to the conclusion that "the value of authentic activity is not constrained to learning in real-life locations and practice, but that the benefits of authentic activity can be realized through careful design of Web-based learning environments."[10] Today's Web-based learning environments give students access to many of the same resources that professionals use in their research.

With Web-based access to radio astronomy data, for example, students have discovered stars overlooked by veteran researchers. History students with access to American Civil War archives are drawing their own conclusions about the history and sociology of the time.[11] With online access to remote instruments, students are using rare or expensive equipment to run experiments and interpret data for themselves. In the process, they are dealing with incomplete and uncertain information, coming to grips with complex patterns, and realizing the messiness of real-life research where there may not be a single right answer.

Technology is also providing access to phenomena that might otherwise remain opaque to many novices, particularly so-called experiential learners. Software visualizations, images, audio, and haptics bring abstractions to life. For instance, when scientific, mathematic, and engineering concepts require learners to build abstract mental models that involve invisible factors, such as intangible force fields and interactions among charged particles, visualization and haptic devices can be used to help learners feel force, pressure, and temperature.[12]

However, access to digital archives, databases, instruments, or even haptic devices may not guarantee an authentic learning experience without the most important factor: community participation. In authentic learning situations, tasks are accomplished collaboratively, whether or not distance is involved. Educators can use Web-based communication tools to help students collaborate with one another, sharing and constructing knowledge. Social

networking tools such as del.icio.us, or citation management tools for researchers such as Connotea, can help learners find a broader community willing to share information and references. And students can reflect on their learning and performance by taking "snapshots" of their group activities with the help of blogs, e-portfolios, quizzes, and video-capture tools.

Authentic learning can rely on educational software developed to simulate typical scenarios that professionals encounter in real-world settings. Along with communications tools, these online experiences often integrate intelligent tutoring systems, concept mapping, immediate feedback, and opportunities for reflection, including the chance to replay recorded events and adopt alternative decision paths. For example, when educational researchers reported that new teachers were having difficulty translating the theories they learned in graduate school into effective real-world practice, developers at the University of Wollongong, the University of Missouri, and Nanyang Technological University in Singapore devised educational software that would help them manage behavioral and learning issues in the classroom. The software taps into the various pressure situations and emotions teachers are likely to experience as they engage their students in a lesson.[13] As the simulation unfolds, the new teacher plans and implements a lesson, views the effects of the lesson from multiple student perspectives, receives feedback and advice from online mentors, and explores alternatives by pausing or repeating the entire learning episode. The simulation also makes use of research data documenting the way exemplary teachers manage behavioral and learning issues in classroom settings.

Finally, some technologies allow students to cohabit the same persistent simulation (or "metaverse"), engaging in collaborative role-playing, grappling with multiple perspectives on the same set of issues, and responding to a dynamically changing situation.[14] In the future, vivid simulations of clinics, schools, laboratories, and other workplaces may augment the conventional internship experience, but only if they offer learners immediate access to one another, to an extended family of mentors, and to the resources of the global network.

Technological support for today's authentic learning environments commonly includes:

- High-speed Internet connectivity for provision of multimedia information, including dynamic data and practical visualizations of complex phenomena and access to remote instrumentation in conjunction with expert advice.
- Asynchronous and synchronous communication and social networking tools for the support of teamwork, including collaborative online investigation, resource sharing, and knowledge construction.
- Intelligent tutoring systems, virtual laboratories, and feedback mechanisms that capture rich information about student performance and help students transfer their learning to new situations.
- Mobile devices for accessing and inputting data during field-based investigations.

What Makes Authentic Learning Effective?

Authentic learning aligns with research into the way the human mind turns information into useful, transferable knowledge. Cognitive scientists are developing a comprehensive portrait of the learner. Three principles illustrate the alignment between learning research and authentic learning:

- *Learners look for connections*: When we approach a subject for the first time, we immediately try to perceive the relevance of the new concept to our lived experience. When a new piece of information simply doesn't fit in any of our existing knowledge structures (or "schemas"), it is often rejected. This means that the more encouragement a learner has to become invested in material on a personal level, the easier it will be to assimilate the unfamiliar.
- *Long-lived attachments come with practice*: Concepts need to be "aired" repeatedly and regularly, defended against attack, deployed in new contexts, and associated with new settings, activities, and people. Otherwise, the attachment is broken and the information lost.[15]
- *New contexts need to be explored*: The concepts being learned are always part of a much larger "learning event" and are directly linked in the learner's mind with social circumstances—the setting, the activities, the people.[16]

Along with this emerging learner profile, cognitive scientists are studying the mind-set of the educator or subject matter expert, with some illuminating results.

- *Experts have blind spots:*[17] Most faculty receive little or no training in the art and science of instruction and tend to rely on their intuitions about how novices learn. Current learning research demonstrates that those intuitions are commonly faulty simply because the instructor is an expert in the field. The longer experts continue to work in their discipline, the further removed they become from the perspective of the novice. Known as "the expert's blind spot," this inability to recognize (or empathize with) beginning students' difficulties can lead expert instructors to teach in a manner that makes sense from their perspective but not necessarily from the student's perspective.[18]
- *Educators evoke feelings:* The teacher-as-facilitator can make or break a learning event. Learning methods evoke feelings in students that reinforce, support, or detract from knowledge construction.[19] Since even the cleverest team of students dealing with complex, sustained investigations may have difficulty making good judgments in the absence of appropriate "scaffolding," it is the educator's role to design appropriate comprehension checks and feedback loops into the authentic learning exercise, preferably the very kinds of interventions commonly exhibited in real-world settings. For example, students engaged in publishing a peer-reviewed journal will evaluate each other over the course of the project and may receive additional guidance from the educator in the role of publisher or editorial board member.
- *Higher education should include the conative domain:* Instructors that provide engaging activities supported by the proper scaffolding can help students develop expertise across all four domains of learning:
  - Cognitive capacity to think, solve problems, and create
  - Affective capacity to value, appreciate, and care
  - Psychomotor capacity to move, perceive, and apply physical skills
  - Conative capacity to act, decide, and commit

Researchers warn that higher education has focused for too long on inculcating and assessing those cognitive skills that are relatively easy to acquire—remembering, understanding, and applying—rather than the arguably more important skills of analyzing, evaluating, and creating.[20] Moreover, in developing these lower-order thinking skills, educators have largely ignored the other major learning domains, particularly the conative,

which determines whether a student has the necessary will, desire, commitment, mental energy, and self-determination to actually perform at the highest disciplinary standards. By engaging students in issues of concern to them, from global warming to world hunger, authentic learning awakens in learners the confidence to act.

Those who adopt innovative learning strategies must be ready to adjust their assessment strategies accordingly. Otherwise, the purpose of the entire enterprise may well be defeated. There are eight critical factors that researchers say must be aligned to ensure a successful learning environment:

- goals
- content
- instructional design
- learner tasks
- instructor roles
- student roles
- technological affordances
- assessment

An educator can introduce authentic content, replacing textbooks with historical documents and scientific data from remote sensors. She can design problem-based activities to replace lectures. She can expect students to collaborate with one another (despite student resistance to these active requirements). She can even surrender some of her own power as an expert to join students as a colearners. And she can support all this innovation with visualizations, simulations, and interactive technologies. Still, she may not achieve her goals if she neglects to rethink her assessment strategies.

After all, what is the use of adopting loftier goals for yourself and your students if you continue to use multiple-choice tests that seek the "right" answer, capturing only the lower-level knowledge that is easiest to measure? Rather than relying on a single assessment method, instructors who adopt authentic learning methods must analyze multiple forms of evidence to measure student performance, including observations of student engagement and artifacts produced in the process of completing tasks.[21]

Why Is Authentic Learning Important?

Jean Lave and Etienne Wenger argue that all would-be scientists, mathematicians, engineers, and historians need to be "enculturated" into the discipline—and the earlier, the better.[22] Along with memorizing facts and practicing technical procedures, beginning students should be learning what John Seely Brown calls the "genres" of the discipline—the schema through which full members of the disciplinary community "recognize whether a problem is an important problem, or a solution an elegant solution, or even what constitutes a solution in the first place."[23] What's more, students should know what it feels like for actual stakeholders beyond the classroom to hold them accountable for their work products. So, whether the learning activity results in a business plan, a set of design specifications, a presentation to the city council, or a short film, evaluation occurs naturally over the course of the project, coming from several sources (as it would in real life), including peers, supervisors, and

clients. The goal is to give learners the confidence that comes with being recognized as "legitimate peripheral participants" in a community of practice.

Authentic learning may be more important than ever in a rapidly changing world, where the half-life of information is short and individuals can expect to progress through multiple careers. According to Frank Levy and Richard Murnane, expert thinking and complex communication will differentiate those with career-transcending skills from those who have little opportunity for advancement.[24] Expert thinking involves the ability to identify and solve problems for which there is no routine solution. This requires pattern recognition and metacognition. Another differentiator is complex communication, such as persuading, explaining, negotiating, gaining trust, and building understanding. Although foundational skills (reading, writing, mathematics, history, language) remain essential, a more complex set of competencies are required today. These go beyond being technically competent to being able to get things done, demonstrate ethics and integrity, and work well with others. According to employers, the most important skills in new hires include teamwork, critical thinking/reasoning, assembling/organizing information, and innovative thinking/creativity.[25]

Why isn't authentic learning more common? The reliance on traditional instruction is not simply a choice made by individual faculty—students often prefer it. This resistance to active learning may have more to do with their epistemological development than a true preference for passivity. Entering freshmen are likely to use a right-or-wrong, black-or-white mental model. At this dualistic stage, students believe that the "right answer exists somewhere for every problem, and authorities know them. Right answers are to be memorized by hard work."[26] By confronting students with uncertainty, ambiguity, and conflicting perspectives, instructors help them develop more mature mental models that coincide with the problem-solving approaches used by experts. Authentic learning exercises expose the messiness of real-life decision making, where there may not be a right or a wrong answer per se, although one solution may be better or worse than others depending on the particular context. Such a nuanced understanding involves considerable reflective judgment, a valuable lifelong skill that goes well beyond the memorization of content.[27]

To be competitive in a global job market, today's students must become comfortable with the complexities of ill-defined real-world problems. The greater their exposure to authentic disciplinary communities, the better prepared they will be "to deal with ambiguity" and put into practice the kind of "higher order analysis and complex communication" required of them as professionals.[28]

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The EDUCAUSE Learning Initiative (ELI) is a community of higher education institutions and organizations committed to advancing learning through IT innovation. To achieve this mission, ELI focuses on learners, learning principles and practices, and learning technologies. We believe that using IT to improve learning requires a solid understanding of learners and how they learn. It also requires effective practices enabled by learning technologies. We encourage institutions to use this report to broaden awareness and improve effective teaching and learning practice.